Zinc Speciation in Fungus from Contaminated Forest Soils

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INTRODUCTION

Much of the forest land in Southern Norway is heavily contaminated with various metals, including Zn, Cu, Pb, Cd. The source of contamination is from metal refining industries, mostly having occurred over the past twenty years. Today, environmental regulations are much more rigid and so this contamination is mostly residual. Large quantities of the contaminant metals are taken up by soil fungi in the top organic layer of the forest surface soils. These species are called ectomycorrhizal fungi and they are known to form symbiotic relationships with the trees via the root network. The fungi obtain carbohydrate from the tree roots in return for mineral supplies from the fungi. We have begun to study these ectomycorrhizal fungi using X-ray Fluorescence Microscopy and micro-XAFS to examine the extent and speciation of metals which are taken up. Whilst it is known that the fungi take up great quantities of the heavy metals, little is known of the precise forms in which they are retained nor of the mechanisms of uptake and conversion. Using the new micro X-ray absorption facility (micro-XAS) at the ALS (1) we have initiated a preliminary study of this problem.

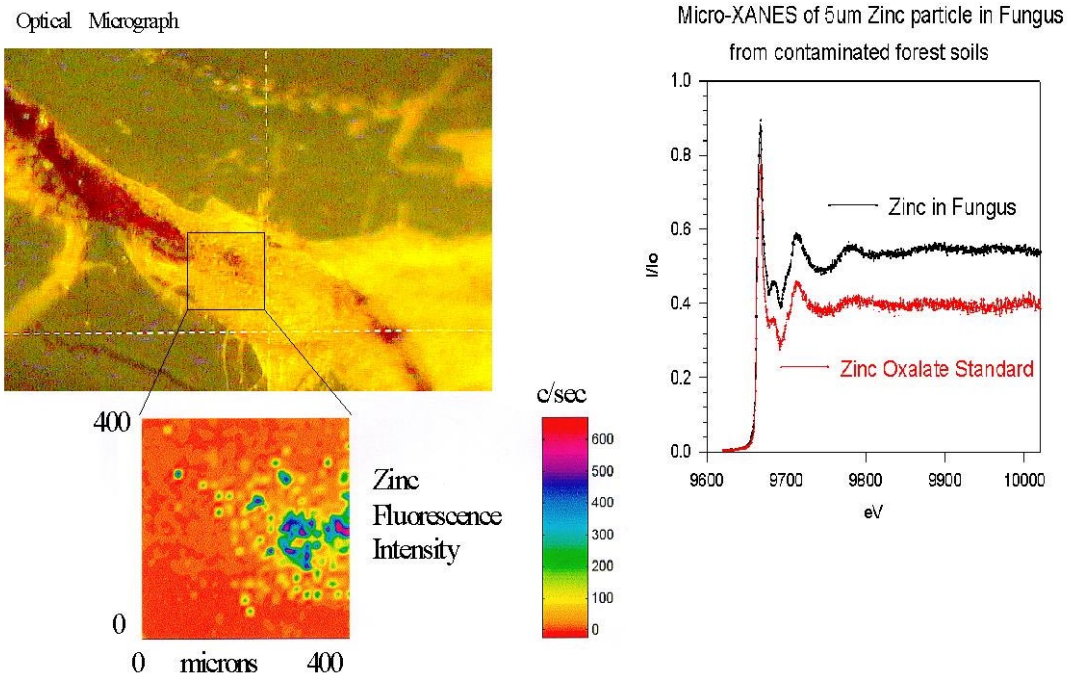

Figure 1. Optical micrograph of fungi in its natural state (top left) with Zinc elemental fluorescence map (lower left). Also included are the near edge zinc XAS spectra of the high concentration zinc particles and a zinc oxalate statndard.

EXPERIMENTAL

The micro-graph shows an area on a sample of the live fungus. A 400 x 400 micron area of interest is marked on the image. The elemental distribution of Zn within that area is indicated by the X-ray fluorescence intensity map shown below the micro-graph. This map shows that the Zn is localized in very small regions of dimensions of only a few microns.

On the right hand side we see the micro-XAFS scans taken by placing the monochromatic micro-beam on the area of greatest concentration and scanning over the Zn K edge at 9659 eV. The signal/noise is sufficiently good to scan some way into the Extended XAFS region, which indicates the potential for extracting structural parameters for this system. In this case a preliminary analysis of the short extended region is consistent with the observation by simple comparison with the very distinctive XAFS from the zinc oxalate standard, that there is a high likelihood that this species is Zinc oxalate. In addition, our conclusion supports that of recent work by Sarret et al. (2), which showed using conventional XAFS, that for zinc sequestered by lichen (a symbiotic microorganism consisting of an algae and a fungi) under similar conditions of contaminant exposure, the dominant product is zinc oxalate.

This experiment demonstrates the capability of making a direct species determination on a very small spatial scale. The results suggest that zinc oxalate is important in the mechanism of contaminant uptake, retention or conversion in its symbiosis with higher plants.

REFERENCES

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